Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices

1457 Issued July 20, 1912.

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—CIRCULAR 117.

A. C. TRUE, Director.

A WORKING EROSION MODEL FOR SCHOOLS.

BY

DON CARLOS ELLIS,

In Charge, Educational Cooperation, Forest Service.

ISSUED BY THE
OFFICE OF EXPERIMENT STATIONS
IN COOPERATION WITH THE
FOREST SERVICE.

[H. S. GRAVES, Forester.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1912.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., April 26, 1912.

Sir: I have the honor to transmit herewith and to recommend for publication as a circular of this office a manuscript describing a working erosion model designed to illustrate graphically the erosion of hillsides and the destruction of farms in the lower valleys following the complete removal of forests from the hills. The model has been thoroughly tested at expositions and is one that can easily be constructed in a school building for use by classes in nature study, agriculture, and physical geography.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

45668°—Cir. 117—12

ILLUSTRATIONS.

Page.

FIG. 1. Model showing the effects of rainfall upon two adjacent hills, one covered with forest growth and the other devoid of such protection..... 5
2. Top plan of model..... 7
3. Vertical section of model..... 8
4. Front elevation of model..... 9

A WORKING EROSION MODEL FOR SCHOOLS.

ESSENTIAL FEATURES OF THE MODEL.

A working model showing the processes of erosion on deforested slopes has been a feature of exhibits made by the Forest Service at recent expositions. It shows the working out of the natural phenomena so well, and is so simple and inexpensive to construct, that a description is here given of a similar model which might be erected in

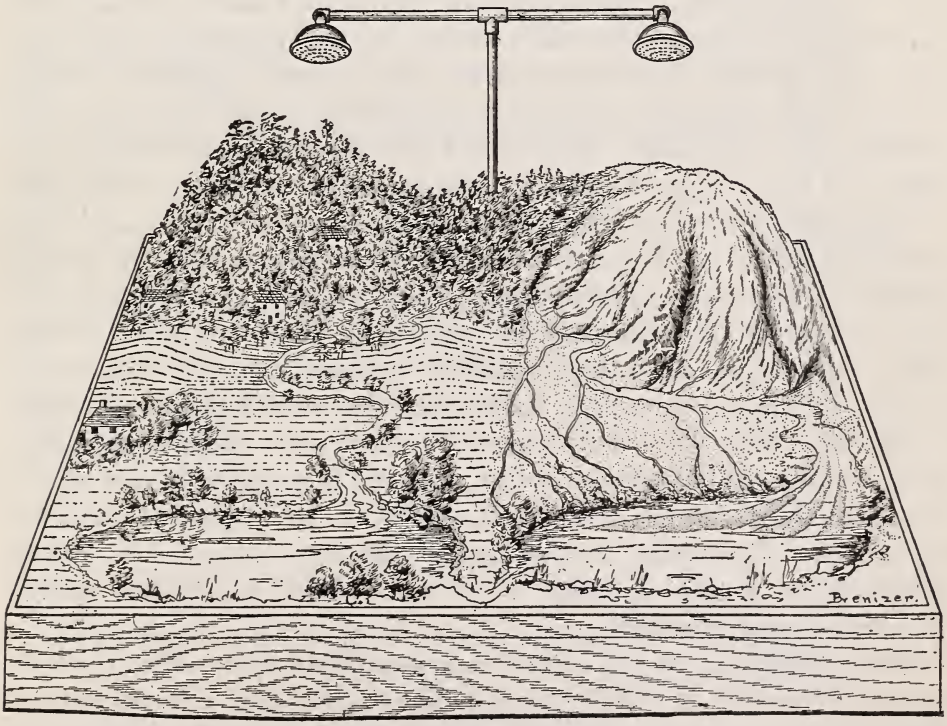

FIG. 1.—Model showing the effects of rainfall upon two adjacent hills, one covered with forest growth and the other devoid of such protection.

schools for the use of classes in nature study, elementary agriculture, and physical geography.

The model consists of two hills sloping down into two valleys through which two streams wind in and out through farm land and lead into two lakes at the front of the landscape. (Fig. 1.) Both hills are made of the same kind of soil, that of the region in which the

model is erected, but one is covered thickly with twigs, young trees, or shrubs, to simulate a forest, underneath which is a heavy carpet of moss representing the layer of leaves and twigs which covers the ground in the real forest, while the other hill is bare of all vegetation.

By means of a suitable sprinkling device water in the form of rain is made to fall with equal force upon the two hills. On the forested slope its fall is broken by the foliage and it drops gently upon the moss-covered surface of the ground. The moss and the soil beneath, which is kept soft and porous by the protective cover, quickly absorb the rain and allow it to seep out as clear water farther down the slope, thus forming a mountain stream which flows through a green and fertile valley into a clear lake at the lower end of the model.

On the other slope the rain beating down upon the unprotected and hardened surface washes deep gullies in the hillside, carries the soil into the turbid stream which drains the valley below, and thence into a muddy lake. The erosion on the slope loosens stones, which are carried down upon the valley farms; the silt deposited in the channel of the stream diverts the water, which opens up gullies through the dry land; the main stream is made shallower and wider and often overflows into the fields; islands and silt bars rise in the stream; and deltas are built up in characteristic form at the entrance to the lake.

The erosion processes which work themselves out in this model, the wearing down of the hill, the silting up of the stream bed, the gradual shifting of the course of the stream, the formation of deltas and sand bars in the lake, and the gradual opening up of watercourses through them are all typical of the processes constantly going on in nature and show strikingly the close relationship between forests and surface formation. It is the same process of erosion on a larger scale which, after the destruction of our forests, causes the removal of the top soil from our slopes, cuts them up into gullies, and deposits sand and gravel upon the fertile alluvial soil of the bottom lands, in storage reservoirs, or in the channels of streams, where it impedes navigation and causes overflow.

While the model is not intended primarily to show more than the erosion processes, it can be used to show also that a forest-covered slope acts as a reservoir in impounding the water and allowing it to seep slowly into the streams, and, on the other hand, that water runs off the surface of a bare slope as soon as it falls, resulting in floods when the precipitation is heavy and in droughts during a dry season. If the sprinkler is stopped and all the water taken out of both of the streams and the lakes, the lake on the forested side will, within a few hours, receive a considerable amount of water as seepage from the wooded hillside, while the other lake will remain practically empty.

CONSTRUCTION OF THE MODEL.

Convenience may determine the size of the model. It may be as small as 4 feet square, but 7 feet square is probably a better size for working out all of the phenomena. Directions are here given for a model 5 feet square.

Construct a strong tray measuring, on the inside, 5 feet square and about 6 inches deep, with the sides reenforced with heavy nails so as to resist the warping of the wood when wet. The bottom of the tray should be made of tongued and grooved material running from front

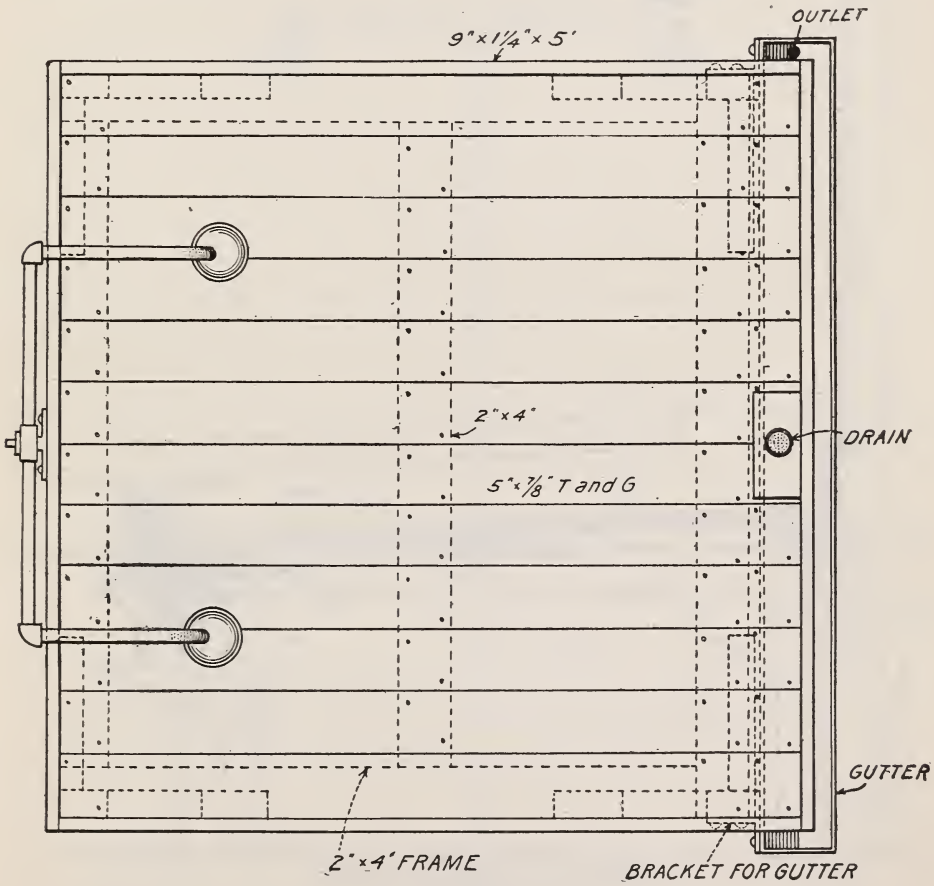

FIG. 2.—Top plan of model.

to rear and made water-tight with lead paint between the planks and paraffin over the seams. (Fig. 2.) The paraffin should be applied hot and plenty should be used. The rear of the tray might be placed against the wall 2 feet 4 inches from the floor, and the front placed on legs 2 feet high. This will give a sufficient slant for good drainage. (Fig. 3.)

Now fill the tray within about 2 inches of the top with rubble and earth, with the general slant of the surface toward the center of the

front of the tray. Slight depressions should be made in the soil, as foundations for the two streams, and two large depressions should be left in the front corners for the lakes. Drainage of these lakes should be provided for by shallow channels running from their surfaces to a drainpipe in the middle of the front of the tray or in some other suitable place.

Next, place from 1 to 2 inches of mortar, consisting of about one part cement and two parts sand, over the entire surface. The

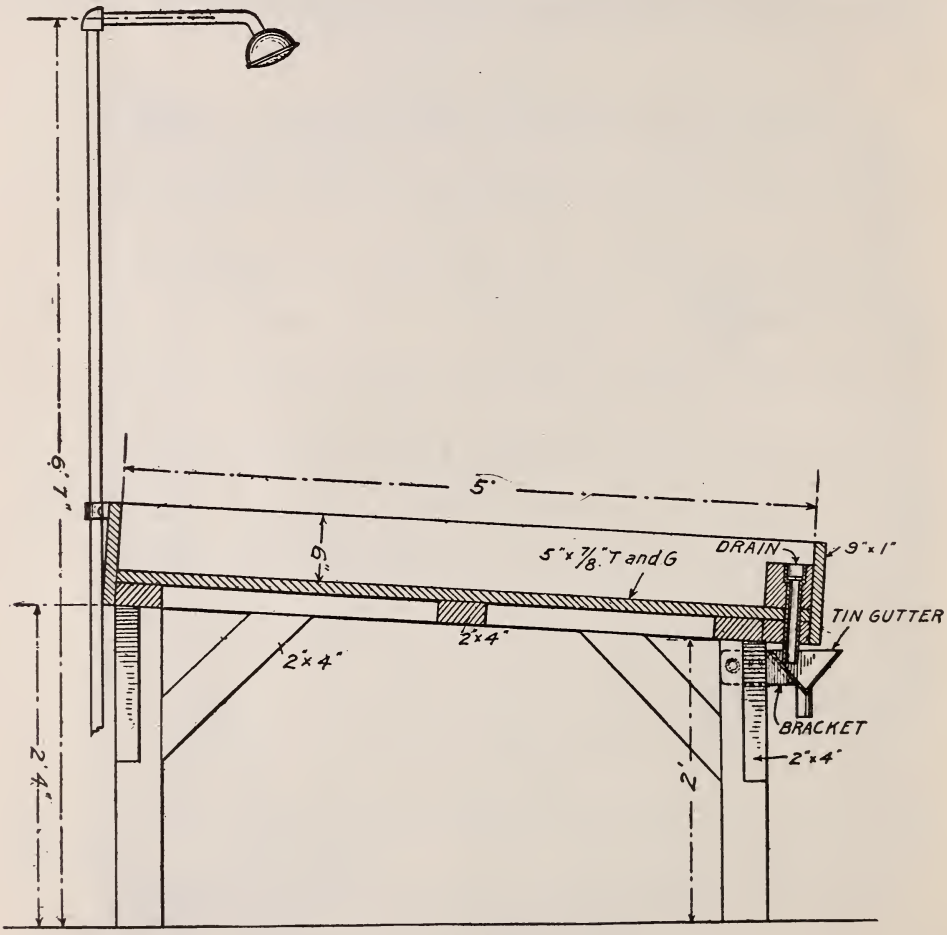

FIG. 3.—Vertical section of model.

mortar should be stiff enough to maintain its shape. Work in the stream beds and the lake depressions before the mortar sets, taking care that the outlets of the lakes are only slightly lower than the intakes at the mouths of the streams. Of course, the more irregular the stream beds are made, the more natural will they appear when finished. Little sinuses, swimming holes, obstacles, and inequalities in elevation to create waterfalls, and similar natural touches will add attractiveness. In applying the mortar care should be taken to retain the general direction of the slant toward the center of the front

of the model. Let the mortar dry out for several days, then paint the surface with hot paraffin and burn in the paraffin with a plumber's hand furnace or Bunsen burner. The model should now be waterproof, but it is safer to run a gutter along the front to receive the drippings. (Fig. 4.) The drain from the surfaces of the lakes should also be directed into this gutter, which should empty into a waste pipe.

When the mortar is hard, erect a mound of earth on each of the rear corners of the model, about 1½ feet in height, and so arranged that the front slope of each drains into one of the streams. The hills may

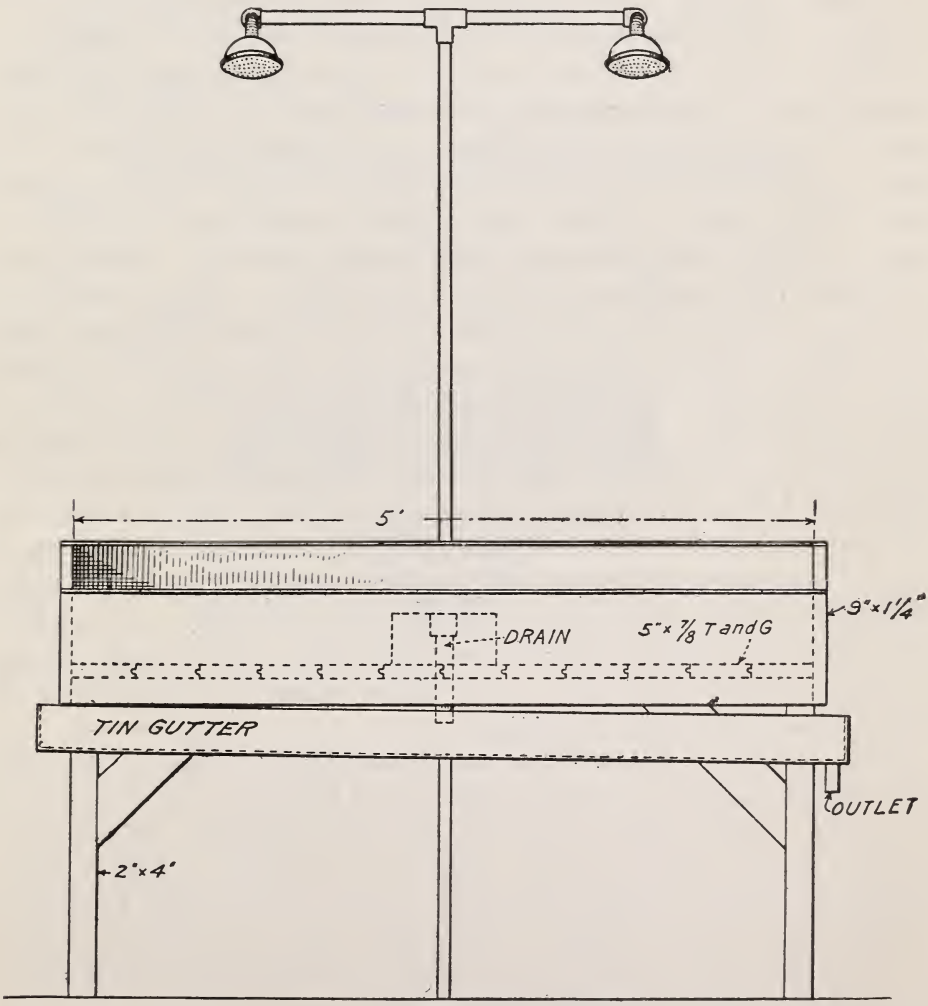

FIG. 4.—Front elevation of model.

be made to appear as two peaks, with a depression between them. Cover one of the mounds thoroughly and thickly with moss, which can be gathered in the woods or purchased by the sack from a florist, and through this moss stick small twigs or trimmings of hedges to represent a forest. Cedar, arbor vitæ, or juniper twigs prove most

satisfactory. Stretches of nearly level land should extend from the bases of the hills to the lakes. The land below the forested hill should be covered with a thin layer of top soil furrowed to represent cultivated fields. The parts of these fields adjacent to the stream and lake should be protected from washing by moss and shrubbery.

A double sprinkler should send with moderate force an equal rain-like spray over each hill. The spray should strike each hill in such a way that all the water will be drained into the corresponding stream. No water should flow down the rear slopes of the hills. One kind of sprinkler is made as follows: A water pipe is run up the wall behind the model to about 1½ feet higher than the summits of the hills. To the upper end of this pipe a "T" is attached, the arms of which run out about 1¼ feet on each side, and from the ends of these arms pipes terminating in sprinklers are run forward so as to bring the spray upon the proper parts of the slopes. A stopcock should be near at hand, so that the force of the water can be easily regulated within sight of the model. Rubber hose might be substituted for both the supply and the drainpipes and would reduce the cost. Baking pans perforated with a nail may be used as sprinklers. Great care should be taken to have the entire surface of the forested hill upon which water falls protected with moss, so that the soil can not be washed away. The water coming from the forested hill will be muddy at first, but will clear after running for a few minutes, and the mud in the water in the lake will soon settle. Erosion will set in upon the deforested hill and the land below as soon as the water is turned on.

The drain should be large and should be protected by a screen or trap so that pieces of leaves and moss can not get into it. A spiral of wire inserted in the upper end of the pipe will suffice. It is advisable also to have the water from the muddy lake pass through a clump of moss or other close sieve, to clear the water of some of the silt before it passes into the drainpipe.

White sand and pebbles and small goldfish or turtles in the clear lake will add another touch of realism and bring out the clearness of the water. Other ideas to add to the picturesqueness and instructiveness of the model can be worked in, such as a road running through the fields, bridges across the streams, and a little farmhouse or barn appropriately placed. The bridge across the muddy stream can be represented as damaged by floods, and the road on that side of the model muddy and deeply furrowed.

Materials for a model 5 feet square.

Lumber:

60 linear feet, 5 inches by ⅞ inch tongued and grooved flooring.
53 linear feet, 2 inches by 4 inches.
21 linear feet, 1¼ inches by 8 inches.

Other material:

1 bag of cement.
2 bags of sand.
1 barrel of rubble or small rocks.
5 pounds paraffin.
2 square yards of moss.
1 peck of top soil.
1 bundle of twigs or cuttings.
1 piece, 5 feet long, of $\frac{3}{4}$-inch iron pipe, both ends threaded.[1]
1 piece, 5 inches long, of 1-inch iron pipe, not threaded.[1]
4 pieces, each $1\frac{1}{4}$ feet long, of $\frac{3}{4}$-inch iron pipe, both ends threaded.[1]
2 single $\frac{3}{4}$-inch elbows.[1]
1 $\frac{3}{4}$-inch "T."[1]
2 sprinklers, similar to illustration (figs. 2 and 3).[1]
1 stopcock.
1 zinc or tin gutter $5\frac{1}{2}$ feet long.
Pipe or hose to connect supply and drain with model.

[1] Other material may be substituted to suit a different style of contrivance.

ADDITIONAL COPIES of this publication may be procured from the SUPERINTENDENT OF DOCUMENTS, Government Printing Office, Washington, D. C., at 5 cents per copy